Load balancing and lifetime maximization in WSN

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Abstract—Strategies that balance the energy consumption of the nodes and ensure maximum network lifetime by balancing the load are proposed and analyzed. Multiple transmission power levels are used. We studied an optimal solution for calculating the hop-by-hop traffic proportions for the particular case of nodes having just two transmission power levels, and compared the results given by the heuristics with those from the optimal analytical case.

I. INTRODUCTION

The lifetime of Wireless Sensor Networks (WSN) is crucial. Network lifetime is the time span from the deployment to the instant when the network is considered non functional. This however is application-specific. It can be, for example, the instant when the first sensor dies, a percentage of sensor die, the network partitions or the loss of coverage occurs [1]. Although different definitions of lifetime exist in the literature [1-2], a sensor network that has a specifically defined grid topology, as we considered in our research, certainly has to be considered "dead" whenever it is no longer able to forward data to the BS. We analyze and propose strategies that balance the energy consumption of the nodes and ensure maximum network lifetime by balancing the load. The research was developed in the framework of the "CAPTEURS" project. The aim of the project was to design a solution [3][4][5] for monitoring the temperature on the whole cold chain, from the warehouses to the retailer, and being aware of the fact that minimizing energy consumption is a key goal in many multi-hop wireless networking systems, especially when the nodes of the network are battery powered. Nodes are uniformly and stationary deployed. In order to achieve an extension in lifetime of the network, two transmission power levels (TPL) are used.

II. LOAD-BALANCING STRATEGIES FOR LIFETIME MAXIMIZATION IN WSN

Equal-Probability Heuristic: This heuristic is the less complex one. Whenever a packet arrives to a node and it should be forwarded through the network with the BS (Fig. 1) as the final destination, the node chooses randomly, with equal probability, the neighbour to send the message to.

Shortest-Path Heuristic: This method chooses the shortest path, or shares the load between the shortest paths to the BS, when the node has several. In the context of energy balancing the shortest-paths are the paths that have the lowest cost in terms of energy consumption.

Contribution-Based Heuristic: Here it is proposed a heuristic which attempts to improve the load balancing and increase the network lifetime by distributing contributions from the BS to the network, depending on the number of neighbours and corresponding power level.

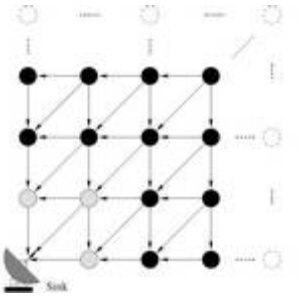

Figure 1. WSN with a grid topology and Sink in the corner. Sensors near the Sink will die faster than the other ones.

III. SIMULATION RESULTS

Simulation results are compared to analytical results [4].

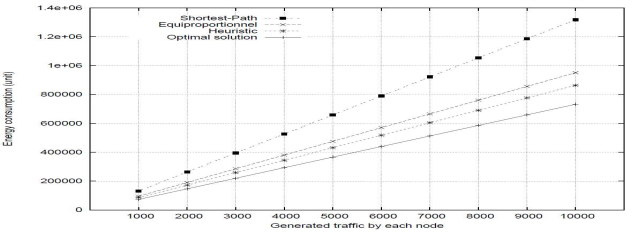

Figure 2. Maximum energy consumption (BS in the corner of a 10x10 grid)

The simulation supposed that each node from a 10x10 grid, initially had a total energy of 30000 units, and the network lifetime is expressed by the number of packets that are sent from the critical node before it dies. The chart from Fig. 2 shows us that the contribution-based heuristic is the most close to the optimal and it is superior to the other two strategies. The equal-probability strategy overcomes the shortest-path in the case in which BS is in the corner.

IV. CONCLUSION

When the TPL increases there is a visible critical load decrease. Indeed, it is more convenient for the overall power consumption for the nodes to send as far as they can towards the BS to maximize the lifetime of the network.

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